Amendments to the Specification:

Please replace paragraph [0011] with the following paragraph:

[0011] Figure 4B shows the image of Figure 4A after it has been subjected to a line-thinning ~~processes~~ process;

Please replace paragraph [0031] with the following paragraph:

[0031] Figure 20 is a view illustrating thin-line condensing operation and expanding operation by the edge-width standardizing section shown in Figure 19[[.]]; and

Please replace paragraph [0034] with the following paragraph:

[0034] Camera 101 is a high speed camera having CCD, CMOS or other image pickup elements, and it can take consecutive images of objects from ahead of the vehicle. The image frames are output to image memory 102. The camera 101 is arranged on the upper front portion of the vehicle, as shown in ~~Figure 2~~ Figures 2A and 2B. Its sight of view axial direction Z is in front of the vehicle. It is set such that horizontal axis X of the imaging area is parallel to the ground surface, and vertical axis Y of the imaging area is perpendicular to the ground surface. The images taken by camera 101 are consecutively output and stored in image memory 102.

Please replace paragraph [0036] with the following paragraph:

[0036] Controller 103 processes image 3a stored in image memory 102, as will be explained later, detects the object present ahead of the vehicle ~~itself~~, and when there is a danger of collision of the vehicle ~~itself~~ with the object present ahead of the vehicle ~~itself~~, it outputs an alarm (alarm sound) to the driver by means of speaker 105, and automatic braking device 106 is controlled to automatically brake or stop the vehicle ~~itself~~. When the object present ahead of the vehicle ~~itself~~ is detected, first of all, the movement velocity in the lateral direction (horizontal direction) of the object present in image 3a is detected, and a velocity image is formed, with the movement direction and movement velocity in the lateral direction of the object in image ~~3a)~~ 3a displayed in graduated values.

Please replace paragraph [0041] with the following paragraph:

[0041] A velocity image is formed, with the velocity component of the object present in image ~~3a)~~ 3a computed in the processing represented by the prescribed grade value. As shown in velocity image 5a in Figure 5, as the grade value of the velocity component in the velocity image in this embodiment, the pixels for which the velocity has been detected are represented by round dots, with higher movement velocities being represented by larger dots. Also, the velocity towards the right side is represented by solid dots, while the velocity towards the left side is represented by circles. That is, as shown in Figure 5, a velocity from road edge B on the right hand side of the road to the left hand side of the image is detected, and the velocity to the right hand side of the image is detected from road edge A on the left hand side of the road and from pedestrian C. Also, it is possible to judge from the size of the dots that the movement velocity detected for pedestrian C is higher than that detected for road edges A and B.

Please replace paragraph [0044] with the following paragraph:

[0044] The start point and the end point, etc., are extracted from the oblique lines, detected as road edges in the regions for detecting the boundary line, as the representative points. For example, representative point 6i is extracted from region 6a for detecting the boundary line, and left representative point 6j is extracted from region ~~6e)~~ 6e for detecting the boundary line. Double regression analysis is carried out on the basis of the extracted representative points, and the equation of the oblique lines in the XY coordinate system is derived. As a result, the two-dimensional road model represented by Equation (1), that is, the imaged road model, is obtained.

$$x = a1 \cdot y^2 + b1 \cdot y + c1 \quad \cdots \quad (1)$$

Please replace paragraphs [0047]-[0049] with the following three paragraphs:

[0047] The histogram of the velocity image is then computed from object lower end position 7c in the Y-axis direction. That is, the histogram that represents the distribution of number of degrees in the X-axis direction of the pixels having the same velocity component towards center 7a of the two-dimensional road model and present from object lower end

position 7c in the Y-axis direction is computed~~ and assuming~~. <u>Assuming</u> the coordinate of the object lower end position 7c is y_d and the degree number of the pixels having the same velocity component towards center 7a in the two-dimensional road model in the Y coordinate value is ~~$V_{(yi)}$~~ <u>$V(y_i)$</u>, the sum of the degree numbers in the range of the preset standard height y_m of pedestrian C is computed using following Equation (2).

$$\sum_{i=m}^{d} V(y_i) > T1 \quad \cdots (2)$$

[0048] When the sum of the degree numbers computed using Equation (2) exceeds a prescribed value T1, it is judged that there exists an object moving towards center 7a of the two-dimensional road model in the range where the pixels having a velocity component towards center 7a of the two-dimensional road model are distributed. When it is judged that there exists a moving object at the position higher than preset standard height y_m of pedestrian C, the position right before degree number ~~$V_{(yi)}$~~ <u>$V(y_i)$</u> having the velocity component towards center 7a of the two-dimensional road model in the y-coordinate value is less than prescribed value T2, such as the position indicated by portion 8a in Figure 8, is detected as the upper end position where the moving object is present, that is, object upper end position 8a.

[0049] In addition, for the region between object lower end position 7c and object upper end position 8a, a straight line is drawn parallel to <u>the</u> Y-axis and passing through the outermost pixel of the pixels having the same velocity component towards center 7a of the two-dimensional road model and present continuously in the X-axis direction. The region defined by the straight line parallel to the Y-axis as well as object lower end position 7c and object upper end position 8a is defined as region 8b where the moving object is present (object presence range). As a result, the pixels in velocity image 5a having the same velocity component towards center 7a of the two-dimensional road model are grouped, and it is possible to detect object presence range 8b including pedestrian C that moves towards center 7a from the side in the two-dimensional road model.

Please replace paragraphs [0051] and [0052] with the following two paragraphs:

[0051] For example, during the movement downward, that is, in the sinking direction due to pitching of the vehicle itself, the line of sight orientation of camera 101 is downward with respect to that with horizontal road surface as shown in Figure ~~2~~ 2A. Consequently, in this case, as shown in Figure 9, movement takes place in velocity image 5a upward from the position of road edges A and B at time t (9a) to the position of road edges A and B at time t + 1 (9b). Consequently, for the oblique line showing road edge A, the velocity component of movement to the right side in velocity image 5a is detected, and, for road edge B, the velocity component of movement to the left side in velocity image 5a is detected.

[0052] On the other hand, when the vehicle itself moves upward, that is, in the floating direction due to pitching, the line of sight orientation of camera 101 is upward from that when the road surface is horizontal as shown in Figure ~~2~~ 2A, and in conjunction with this pitching, the position of road edges A and B on velocity image 5a moves downward. As a result, for the oblique line that indicates road edge A, the velocity component of movement to the left side in velocity image 5a is detected, and, for the oblique line indicating road edge B, the velocity component of movement to the right side in velocity image 5a is detected.

Please replace paragraphs [0058]-[0065] with the following eight paragraphs:

[0058] (1) Level 3. When it is judged that the degree of collision danger between the vehicle ~~itself~~ and pedestrian C is the highest from the relative position relationships between the road edges and pedestrian C, the degree of collision danger is taken to be level 3. That is, as shown in Figure 11, when pedestrian C moves inside the road edge present on the left/right sides indicated by portion 11a, that is, when the pedestrian moves inside the vehicle lines where vehicle 11d is itself running, the degree of collision danger between vehicle 11d ~~itself~~ and pedestrian C is judged to be at level 3.

[0059] (2) Level 2. When it is judged that the degree of collision danger between the vehicle ~~itself~~ and pedestrian C is not as high as level 3 yet there is still the danger of collision from the relative position relationships between the road edges and pedestrian C, the degree of collision danger is taken to be level 2. In other words, when pedestrian C moves in the range indicated by portion 11b, that is, when the pedestrian moves from outside the road edge in a range where the distance from the road edge to pedestrian C is x0 (m) or less, the degree

of collision danger between vehicle 11d ~~itself~~ and pedestrian C is judged to be at level 2. The distance of x0 (m) is computed from the movement velocity of pedestrian C detected in the processing, the distance ~~from~~ <u>between</u> vehicle 11d ~~itself~~ and pedestrian C, and the vehicle speed detected with vehicle speed sensor 107.

[0060] (3) Level 1. When it is judged that there is no collision danger between the vehicle ~~itself~~ and pedestrian C, the degree of collision danger for pedestrian C is taken to be level 1. In other words, when pedestrian C moves in the range indicated by portion 11c, that is, when the pedestrian moves ~~in from~~ <u>out</u> beyond the range of x0 (m) from the road edge, the degree of collision danger between vehicle 11d ~~itself~~ and pedestrian C is judged to be at level 1. When the judgment result of the degree of collision danger is level 1, there is no need to perform vehicle control to avoid collision, to be explained later, because there is no danger of collision between the vehicle ~~itself~~ and pedestrian C.

[0061] Because the degree of collision danger changes depending on the distance from the vehicle ~~itself~~ to pedestrian C, the distance from the vehicle ~~itself~~ to pedestrian C is classified according to the distance computed using the following Equations (3)-(5). Based on the classification result, as will be explained later, vehicle control is performed, as will <u>also</u> be explained later, to avoid collision of the vehicle ~~itself~~ with pedestrian C. In following Equations (3)-(5), V represents the speed of the vehicle 11d ~~itself~~, g represents the gravitational acceleration, <u>and</u> z0 represents the distance 11e from the position on the vehicle line corresponding to the position of pedestrian C and the target stop line.

$$z3 = (1/2) * (V^2 * 0.5g) + V * 2 + z0 \quad \cdots (3)$$

$$z2 = (1/2) * (V^2 * 0.5g) + V * 1 + z0 \quad \cdots (4)$$

$$z1 = (1/2) * (V^2 * 0.6g) + z0 \quad \cdots (5)$$

[0062] Based on the degree of collision danger assessed in the processing and the distance between the vehicle ~~itself~~ and pedestrian C classified according to Equations (3)-(5), vehicle control is performed to avoid collision between the vehicle ~~itself~~ and pedestrian C according to the following listed three control modes (A)-(C).

[0063] (A) Caution. When the degree of collision danger is level 3, and the distance between the vehicle ~~itself~~ and pedestrian C is longer than z2 and shorter than z3, the control

mode is "Caution." When the control mode is "Caution," a caution alarm is output from speaker 105 to alert the driver to the presence of a moving object ahead of the vehicle with which there is a danger of collision.

[0064] (B) Warning. When the degree of collision danger is level 2, or when the degree of collision danger is level 3 and the distance between the vehicle ~~itself~~ and pedestrian C is shorter than z2, the control mode is "Warning." When the control mode is "Warning," a warning alarm is output from speaker 105 to alert the driver to the presence of a moving object ahead of the vehicle with which there is a high danger of collision. Also, this warning alarm is different from that for "Caution" in ~~the~~ control mode (A). For example, the volume for the warning alarm may be higher than that for the caution alarm, or, the caution alarm and warning alarm may have different rhythms.

[0065] (C) Automatic braking. When the degree of collision danger is level 3, and the distance between the vehicle ~~itself~~ and pedestrian C is shorter than z1, the control mode is "Automatic braking." When the control mode is "Automatic braking," automatic braking device 106 is controlled to forcibly brake the vehicle itself. That is, when there is a high danger of a collision with pedestrian C, there may be no time for the driver to perform the braking operation after hearing the caution or warning alarm. Consequently, automatic braking device 106 is in this case forcibly controlled to brake the vehicle ~~itself~~ to stop it. Also, a "warning" is issued while the control mode is "Automatic braking."

Please replace paragraphs [0069]-[0071] with the following three paragraphs:

[0069] In step S11, a change in the velocity direction in the image of the oblique lines indicating the road edges is detected, and a judgment is made as to whether this is the pitching balance point. When it is judged to be the pitching balance point, process flow continues to step S12. In step S12, the positions of the oblique lines indicating the road edges are transformed to positions in real space, and the three dimensional road model is computed. Then, process flow continues to step S14, and the relative positional relationship between the road edge and the detected object in real space, that is, the distance between the road edge and the detected object and the distance between the vehicle ~~itself~~ and the detected object, ~~are~~ is computed. Process flow then proceeds to step S16, as will be explained later.

[0070] On the other hand, when it is judged not to be the pitching balance point in step S11, process flow continues to step S13. In step S13, as explained above, based on the image pickup time interval between the velocity image at the pitching balance point and the current velocity image, the three dimensional road model is estimated, and process flow continues to step S15. In step S15, the relative positional relationship between the road edge and the detected object, that is, the distance between the road edge and the detected object and the distance between the vehicle ~~itself~~ and the detected object, is estimated, and process flow continues to step S16.

[0071] In step S16, based on the relative positional relationship between the road edge and the detected object, the degree of collision danger between the vehicle ~~itself~~ and the detected object is judged as one of the levels 1 3. If the degree of collision danger is judged to be level 1, no vehicle control to avoid collision is performed since there is no danger of collision between the vehicle ~~itself~~ and the detected object, and process flow continues to step S22, to be explained later. On the other hand, when it is judged that the degree of collision danger is level 2 or 3, process flow continues to step S17. In step S17, based on the distance between the vehicle ~~itself~~ and the detected object, the mode of vehicle control for avoiding collision is assessed.

Please replace paragraph [0073] with the following paragraph:

[0073] In step S21, automatic braking device 106 is controlled to forcibly brake the vehicle ~~itself~~. Then, process flow continues to step S22. In step S22, a judgment is made as to whether the ignition switch of the vehicle itself is OFF. If it is not OFF, flow returns to step S1, and the processing is repeated. On the other hand, if it is judged that the ignition switch of the vehicle itself is OFF, the processing comes to an end.

Please replace paragraph [0080] with the following paragraph:

[0080] The block diagram shown in Figure 1, the ~~diagram~~ diagrams shown in ~~Figure 2~~ Figures 2A and 2B for illustrating an arrangement example of camera 101 on a vehicle, and the ~~diagram~~ diagrams shown in ~~Figure 4~~ Figures 4A to 4C for illustrating an example of edge normalization are the same as in the first embodiment and will not be explained again.

Calculation of the ~~2-dimenisonal~~ 2-dimensional road model on the basis of the detected road edges, detection of the object field including the object facing the center of the 2-dimensional road model, the judgment of the degree of risk on the basis of the positional relationship between the object and the boundary lines on the road transformed on the 3-dimensional road model, and the vehicle control or warning operation on the basis of the result of the degree of risk judgment explained on the basis of Figures 7-11 are also carried out in the same way as described in the first embodiment and will not be explained again.

Please replace paragraph [0088] with the following paragraph:

[0088] In the following, the slope condition for detecting a boundary line candidate will be explained. In general, if there are multiple boundary lines on the road on the right or left side viewed from the vehicle in velocity image 14a, the slope of a boundary line close to the vehicle is larger than the slope of a boundary line away from the vehicle. In other words, a boundary line close to the vehicle has a larger angle formed with the x axis than a boundary line away from the vehicle. For example, in the example shown in Figure 14, the slope of road edge E present on the right side of the vehicle is ~~larger~~ smaller than the slope of boundary line F with the adjacent lane dividing line.

Please replace paragraphs [0092] and [0093] with the following two paragraphs:

[0092] Figures 18A and 18B are a flow chart illustrating the processing of object detecting device 100 in the second embodiment. The processing ~~shown in Figure 18A~~ is carried out as a program started by control device 103 when the ignition switch of the vehicle is turned on and the power object for detecting device 100 is turned on. In ~~Figure~~ Figures 18A and 18B, the same step numbers are assigned to the same processes as those that are described in the first embodiment shown in ~~Figure 12~~Figures 12A and 12B, and the explanation focuses on the differences of these embodiments.

[0093] In ~~steps~~ step S4-2, multiple regions 15a for detecting a boundary line are set on velocity image 14a as described above, and each region 15a for detecting a boundary line is further divided into small regions with a prescribed size. Then, process control goes to ~~steps~~ step S5-2. The spatial filter shown in Figure 16B is applied to the target pixel in each

small region to detect the dot candidates. If 3 or more detected candidates are side by side in the oblique direction to form an oblique line in the small region and the straight line formed by connecting these dot candidates satisfies the slope condition, the straight line formed by connecting these dot candidates is detected as a boundary line candidate.

Please replace paragraphs [0096] and [0097] with the following two paragraphs:

[0096] Referring to Figures 19 and 20, an implementation of the processing performed to normalize the extracted edges to obtain an edge image[[,]] as shown in ~~Figure 4~~ Figures 4A to 4C is explained.

[0097] The edge extracting section 202 extracts an edge of an image using a SOBEL filter for the frame image inputted from the camera 101 ~~by generating an edge image~~ as part of an image pickup section 201. The edge standardizing section 203 standardizes an edge width of the edge, extracted by the edge extracting section 202, to a given pixel number in a shift direction of the object.

Please replace paragraphs [0099]-[00101] with the following three paragraphs:

[0099] With the edge standardizing section 203 configured in such a structure, if the edge image is inputted from the edge extracting section 202, the binary valuing section 231 executes a binary valuing operation on the edge image. During this binary valuing operation, a pixel of a pixel area[[,]] whose edge is detected[[,]] is allocated to take "1" while allocating a pixel of a pixel area[[,]] whose edge is not detected to be "0", upon which a binary valued image is generated as shown in a frame image (a) in Figure 20.

[00100] Next, the thin-line condensing section 232 executes a thin-line condensing operation for the binary valued image that is valued by the binary valuing section 231 in a binary state. The thin-line condensing operation is an operation in which the edge width of the detected edge is contracted to a given pixel number. With the frame image (b) shown in Figure 20, the edge width of the edge is condensed to a given pixel number of one pixel. Upon condensing the line of the edge to the given pixel width in such a way, the thin-line condensing section 232 sets a center position to be a center of the edge.

[00101] Subsequently, the expanding section 233 executes an expanding operation for

expanding the edge width of the edge whose line is condensed by the thin-line condensing section 232. During this expanding operation, the edge width is expanded in both shift directions of the edge, that is, in one shift direction away from a center position of the edge, set by the thin-line condensing operation, and in the other direction opposite to the one shift direction. With the frame image (c) in Figure 20, the edge width is expanded in both directions by one pixel, i.e., in the shift direction (positively on the x-axis) away from the pixel position X, forming the center of the edge, and the other direction (negatively on the x-axis) opposite to the shift direction ~~for~~, thereby standardizing the edge width of the edge in three pixels with respect to the shift direction.

Please replace paragraph [00104] with the following paragraph:

[00104] Next, the balloting section 204 executes the operation to count up the standardized edges standardized in ~~a~~ the way set forth above. This count-up operation is implemented such that values of memory addresses of memory regions whose standardized edges are detected are counted up while initializing the values of memory addresses of pixel areas whose standardized edges are not detected.

Please replace paragraph [00106] with the following paragraph:

[00106] As shown in Figure 21, it is supposed that in a frame image ~~(a)~~ (d) at time t, the edge width is expanded from a pixel position X−1 to the other pixel direction X+1 in both directions, including a shift direction of the edge and the other direction opposite to the shift direction, by one pixel, respectively.

Please replace paragraphs [00108]-[00110] with the following three paragraphs:

[00108] In a frame image ~~(a)~~ (d) in Figure 21, since the standardized edges are detected on the pixel positions X−1, X and X+1 at time t, the ballot values are counted up at the respective pixel positions one by one such that the pixel position X+1 takes the ballot value of 1, the pixel position X takes the ballot value of 3 and the pixel position X−1 takes the ballot value of 5.

[00109] No edge shifts at time t+1, the standardized edges are detected at the pixel

positions X−1, X and X+1 and, as shown in the frame image ~~(b)~~ (e) in Figure 21, the ballot values of the pixel positions X−1, X and X+1 are further counted up one by one such that the pixel position X−1 takes the ballot value of 2, the pixel position X takes the ballot value of 4 and the pixel position X+1 takes the ballot value of 6.

[00110] Further, at time t+2, the edge shifts in a positive direction on the x-axis by one pixel upon which the standardized edges are detected at the pixel positions X, X+1 and X+2. Accordingly, the ballot values of the pixel positions X, X+1 and X+2, whose standardized edges are detected, are counted up, while resetting ballot value of the pixel area X-1 whose standardized edge is not detected. As a result, as shown by a frame image ~~(c)~~ (f) in Figure 21, the pixel position X+2 takes the ballot value of 1, the pixel position X+1 takes the ballot value of 3 and the pixel position X takes the ballot value of 5. In addition, the ballot value of the pixel position X−1, whose standardized edge is not detected, is reset to "0".

Please replace paragraphs [00112]-[00115] with the following four paragraphs:

[00112] While in Figure 21[[,]] the ballot values are detected at a sum of three positions, i.e., the pixel positions X−1, X and X+1, as the pixel areas of the standardized edges, the ballot values of any positions may be detected provided that the gradient of the ballot values is obtained as will ~~de~~ be described below.

[00113] Further, if the frame rate is set to be sufficiently higher than the speed in which the edge (at a central pixel position of the standardized edge) shifts, the standardized edges are detected a number of times on the same pixel areas for frame images successively appearing in time series. In case of Figure 21, the standardized edge in the pixel position X is detected two times, at times t and t+1. Consequently, the ballot value[[,]] resulting when the ballot values of the pixel areas whose standardized edges are detected[[,]] is substantially equivalent to a time interval (frame number) during which the standardized edges are detected in the relevant pixel area. Particularly, this means how many number of frames are needed after the edge has shifted for the minimum ballot value h, among the ballot values of the pixel areas on which the standardized edges are located, to be located on the same pixel area.

[00114] Subsequently, the shift speed detecting section 205 calculates a shift speed, a

shift direction and a position of the edge. The shift speed detecting section 205 initially calculates a gradient of the ballot values of the pixel areas of the standardized edges and, depending on the gradient of the ballot value, calculates the shift direction, the shift speed and the position of the edge.

[00115] Hereunder, this calculation method is described with reference to Figure 21. In case of the frame image ~~(b)~~ (e) in Figure 21, the pixel positions X–1, X and X+1 have the ballot values of 6, 4 and 2, respectively. Therefore, upon subtracting the ballot value 2 at the pixel position X+1 from the ballot value 6 at the pixel position X–1, the gradient of the ballot value can be calculated as H = ~~(6*2)/2 = 2~~ (6-2)/2 = 2. This means

Please replace paragraph [00118] with the following paragraph:

[00118] In the frame image ~~(b)~~ (e) in Figure 21, four frames are needed for the standardized edge to shift by one pixel and, hence, the shift speed of the edge can be calculated to be 1/4 (pixel/frame). Likewise, even in the frame image ~~(c)~~ (f) in Figure 21, the gradient of the ballot value is expressed as H = ~~(5*1)/1 = 4~~ (5-1)/1 = 4 and, hence, the shift speed of the edge is expressed as 1/4 (pixel/frame).

Please replace paragraphs [00122] and [00123] with the following two paragraphs:

[00122] In the frame image ~~(b)~~ (e) in Figure 21, since at time t+1[[,]] the edge is detected in the same pixel position two successive frames at the edge speed of 1/4 (pixel/frame), the pixel position of the edge at time t+1 can be calculated to assume a position shifted from the pixel position by

$$2\ (\text{Frame}) \times \{1/4\ (\text{Pixel} / \text{Frame})\} = 0.5\ \text{Pixel}$$

[00123] Upon calculating the shift speed, the shift direction and the position of the edge in such a way, the shift speed detecting section 205 transmits the calculated shift speed to the edge standardizing section 203. Upon receipt of the shift speed, the edge standardizing section 203 alters the edge width of the edge to be standardized. In the frame image ~~(c)~~ (f) in Figure 21, although the edge width, subsequent to the standardizing operation, has three pixels ~~in~~ with respect of the shift direction of the edge, the edge width ~~in~~ with respect of the shift direction of the edge is altered to be greater than the three pixels when the received shift

speed is high~~ whereas when~~. When the shift speed is low, the edge width ~~in~~ with respect of the shift direction of the edge is altered to be smaller than the three pixels.

Please replace paragraph [00125] with the following paragraph:

[00125] As set forth above, the motion detection apparatus and motion detection method of the ~~presently filed~~ second embodiment have advantageous effects, in addition to those of the first embodiment, wherein the edge-width standardizing section 203 is structured to allow the standardized edge width~~, to be standardized,~~ to be altered depending on the shift speed calculated by the shift speed detecting section 205~~ whereby~~. Accordingly, even in the presence of variation in the shift speed of the object, the edge width can be standardized to allow the standardized edges to overlap one another between the successive frames~~ for~~, thereby expanding the range for the shift speed of the object available for detection.

Please replace paragraph [00127] with the following paragraph:

[00127] The following modifications may be made to object detecting device 100 in the ~~embodiment~~embodiments.

Please replace paragraph [00128] with the following paragraph:

[00128] (2) In the first and second embodiments, the grade values ~~shown in~~ described with respect to Figure 5 are adopted to compute velocity image 5a. However, the present invention is not limited to this scheme. For example, one may make adopt other grade values to compute the velocity image.